CONN. COLLEGE
APR 28 '87
NEW LONDON

THE NATURE CONSERVANCY NEWS

February/March 1987

HAWAII: "Islands of Life"

William P. Mull

A mobile home doesn't guarantee a place to live.

Help protect our natural communities
with a gift to the General Fund.

VOLUME 37, NUMBER 1
FEBRUARY/MARCH 1987
(ISSN 0028-0852)

THE NATURE CONSERVANCY NEWS

BOARD OF GOVERNORS
CHAIRMAN OF THE BOARD
G. Jon Roush, *Montana*
VICE CHAIRMEN
Beryl R. Collins, *New Jersey*
Jerry Franklin, *Oregon*
David Harrison, *Colorado*
SECRETARY
Charles M Deaton, *Mississippi*
TREASURER
John A. Hillenbrand, *Indiana*
Robert O. Anderson, *New Mexico*
James K. Bissell, *Ohio*
J. C. Brenton, *Iowa*
William S. Brewster, *Massachusetts*
Samuel A. Cooke, *Hawaii*
Joan K. Davidson, *New York*
Sophie Engelhard, *Idaho*
Daniel J. Evans, *Washington*
Kenneth E. Hill, *California*
George C. Hixon, *Texas*
William S. Huey, *New Mexico*
Orie L. Loucks, *Indiana*
Clifford F. Messinger, *Wisconsin*
Robert L. Mitchell, *Connecticut*
Leigh H. Perkins, *Vermont*
Hon. L. Richardson Preyer, *North Carolina*
John C. Pritzlaff, *Arizona*
Leland S. Prussia, *California*
George Putnam, *Massachusetts*
David E. Reichle, *Tennessee*
Winthrop P. Rockefeller, *Arkansas*
Leonard L. Silverstein, *Maryland*
Peggy B. Sharpe, *Rhode Island*
Daniel Simberloff, *Florida*
William I. Spencer, *New York*
Jack Hood Vaughn, *Virginia*
Jean Vollum, *Oregon*
Richard S. Weinstein, *Florida*

STAFF OFFICERS
Frank D. Boren, *President*
John R. Flicker, *Executive Vice President*
Vice Presidents:
Robert E. Jenkins, *Science Programs*
John W.Humke, *Midwest Region*
Bradford C. Northrup, *Finance/Administration*
David E. Morine, *Land Acquisition*
Ray M. Culter, *Protection Projects*
L. Gregory Low, *Major Program Development*
Michael Dennis, *General Counsel*
Walt Matia, *Stewardship*
Tom Massengale, *Southeast Region*
Dennis Wolkoff, *Eastern Region*
John W. Jensen, *Development*

EDITORIAL STAFF
Sue E. Dodge, *Editor*
Anne M. Byers, *Senior Editor*
Sandy Scholar, *Assistant Editor*
Susan Bournique, *Photo Editor*

Hawaii's Islands of Life:
A Campaign to Stem the Tide of Extinction .. 4
Kelvin H. Taketa

Hawaii: The Eden of Endemism 6
Dwight Holing

The Dunes of Mo`omomi 14
Samuel M. Gon III

A Portfolio/Hawaii 18

Ecology Forum: Sexual Selection
and the Pomace Fly 23
Dr. Kenneth Y. Kaneshiro and Dr. Hampton L. Carson

New Projects 26

COVER: Gray's silversword (*Argyroxiphium grayanum*) is known only from the bogs at the summit of Hawaii's West Maui mountains. Believed to be a member of the daisy family, the plant flowers once in its lifetime and dies soon after. Photo by Robert Hobdy.

The Nature Conservancy is an international membership organization committed to the global preservation of natural diversity. Its mission is to find, protect, and maintain the best examples of communities, ecosystems, and endangered species in the natural world. The Nature Conservancy Latin American Program works to help build in-country institutions to accomplish this purpose.

To date the Conservancy and its members have been responsible for the protection of 2,666,305 acres in 50 states, Canada, Latin America, and the Caribbean. While some areas are transferred for management to other conservation groups, both public and private, the Conservancy owns and manages some 900 preserves—the largest privately owned nature preserve system in the world.

The Nature Conservancy was incorporated in 1951 in the District of Columbia for scientific and educational purposes. The Conservancy is a nonprofit, tax-exempt corporation under Section 501(c)3 of the Internal Revenue Code and is a publicly supported organization as defined in Sections 170(b)(1)(vi) and 509(a). Contributions are tax-deductible.

Copyright 1987
The Nature Conservancy

A copy of the last financial report filed with the Department of State may be obtained by writing to New York State, Department of State, Office of Charities Registration, Albany, New York 12231, or The Nature Conservancy, 1800 North Kent Street, Arlington, Virginia 22209.

Hawaii's Islands of Life:

A Campaign to Stem the Tide of Extinction

Richard A. Cooke III

Peter French

Robert Gustafson

Mo`omomi (top), on Molokai, harbors vast communities of nearly undisturbed native grasses and shrubs. Federally listed as threatened, the `io (above) is a hawk found only on the island of Hawaii. The striking Hibiscus kahili (left), endemic to Kauai, is a candidate for federal listing.

by Kelvin H. Taketa
Executive Director, Hawaii Field Office

According to Hawaiian legends, a particular submerged cave at Mo`omomi harbored a special medicinal sponge. The cavern entrance was believed to be guarded by a supernatural eel. Within, beside the much desired sponge, lurked a great lizard-like monster called a mo`o. Today no one can say with certainty that Mo`omomi was named for the mo`o. This is but one of the many secrets hidden by the dunes of Mo`omomi.

☆ ☆ ☆

THE NATURE CONSERVANCY first learned of Mo`omomi Dunes on the island of Molokai in 1976. It appeared to be an area of such incredible ecological significance (see page 14) that the Conservancy's Hawaii Field Office immediately dispatched staff to survey and photograph the site. Although we began negotiations for its acquisition almost simultaneously, nearly ten years would pass from the date of those first efforts before the Conservancy would realize the opportunity to protect Mo`omomi—now the centerpiece of Hawaii's exciting new "Islands of Life" Campaign.

Inactivity was not the reason why Mo`omomi remained unsecured during the intervening decade. Since 1976, while negotiations for the dunes continued, the Conservancy protected on its own or in cooperation with government agencies nearly 20,000 acres of Hawaiian tropical rain forest: habitat for 14 of the islands' 19 endangered forest bird species. The expansion of the Kipahulu section of Haleakala National Park, the initiation of the Hakalau Preserve (which has since been designated the Hakalau Forest National Wildlife Refuge), and the creation of Conservancy preserves at Kamakou on Molokai, Waikamoi on Maui, and Kaluahonu on Kauai have all been accomplished in just the past ten years.

Since its establishment in 1980, the Conservancy's Hawaii Field Office has increased its membership by 1,000 percent—from 300 members to more than 3,000. Led by a highly supportive and active board of trustees, the Hawaii office completed its $3 million Endangered Hawaiian Forest Bird Project in 1985. Moreover, efforts to pioneer new management methods for protecting tropical forests as well as to create a Hawaiian natural heritage program have drawn the interest of the state's best scientists and have generated a growing volunteer force.

Despite the accomplishments of the past decade, we are now faced with the need to quicken our pace if we hope to preserve Hawaii's remaining natural treasures. Although the archipelago occupies only a tiny fraction of the land mass of the United States, Hawaiian plants and animals currently account for 27 percent of America's rare and endangered species. More than 70 percent of the extinctions recorded in the U.S. in the past two centuries were of plants and animals once found only in Hawaii. Indeed, we are fortunate that Mo`omomi and other areas like it still exist in Hawaii.

FOR MORE THAN a year scientists throughout the islands have been working with staff of the Hawaii Heritage Program to establish conservation priorities for safeguarding the state's natural diversity. Recently they concluded that no fewer than 88 of the 150 different types of natural communities found only in Hawaii—along with the thousands of unique species they support—could all be lost within the next 20 years or sooner if an active program for their preservation is not initiated immediately.

Unrelenting development endangers some of these lands, especially those edging the islands' coastlines, while encroachment and destruction by introduced plants and animals imperil other sites. Tenacious and effective management programs are essential to saving these latter areas.

To counter these immediate threats, the Conservancy's Hawaii office is launching the "Islands of Life" Campaign. Over the next three years we must raise at least $10 million to secure almost half of Hawaii's most endangered natural communities and to provide a permanent trust fund for their continued stewardship. Through the careful selection and design of preserves, we hope to protect a sampling of the myriad habitats and ecosystems found in the islands: windswept sand dunes, mountain bogs a mile above sea level, spring-fed ponds along rocky shorelines, cloud-enshrouded rain forests, dark lava caves, and entire watersheds and free-flowing streams.

A critical component of the campaign is the commitment to provide for long-term management of new preserves. In many cases the most vital part of our work will begin only *after* we acquire an area and initiate stewardship programs. We also hope that many of these sanctuaries will be used by the public—for education, recreation, and research.

The "Islands of Life" Campaign is by far the most ambitious statewide conservation effort ever undertaken in Hawaii. Through it, the Conservancy intends to stem the tide of extinction that is rising with ever-increasing speed in the islands. Throughout Hawaii unsurpassed natural lands—precious islands of life adrift in Hawaii's sea of change—can still be found. If we do not act quickly, many of them will be lost forever. But there is hope. Hope in what the Conservancy has already accomplished and hope in the knowledge that many of the islands' ecological treasures, such as Mo`omomi, can still be saved.

John H. Carothers

HAWAII: The Eden of Endemism

by Dwight Holing

GOLDEN AFTERNOON LIGHT flecks the trunks of ancient `ohi`a trees, clothed in deep red-brown mosses. Each tree in this rain forest on the island of Molokai is a garden supporting dozens of ferns, tree seedlings, twining mints, and silver-green pa`iniu lilies. As the trail opens up, the Papa`ala pali (Molokai's summit ridge) curves away sinuously to the east, and clouds slip across it in a thin veil as wet air rises with the trade winds from Pelekunu Valley below. Flocks of scarlet `apapane ride the wind across this ridge, diving to search for nectar in `ohi`a trees aflame with salmon, scarlet, or yellow blossoms in the summit forests. Molokai's rain forest is otherworldly, a lush jungle wilderness brightened with flowers that flourish nowhere else and with bird songs heard only here. It is a veritable Eden when it comes to endemism, but, as in all Hawaii, its native flora and fauna also are as fragile as dreams.

The Molokai rain forest is just one example of Hawaii's spectacular natural heritage. Hawaii ranks number one in the world for its tally of endemic species, even though it encompasses less than two-tenths of one percent of the planet's total land surface. Almost 100 percent of its invertebrate species occur naturally nowhere else on Earth, as do 98 percent of its birds and 93 percent of its flowering plants. Minnesota, by contrast, has but one endemic plant.

Hawaii's globally unique biota is the result of nature's grand experiment in supreme isolation. Made up of eight major islands—Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii— and more than 100 visible islets, pinnacles, and shoals, the Hawaiian archipelago stretches 1,600 miles across the north central Pacific Ocean to include Midway and Kure, mere atolls. No place is more geographically isolated: the nearest continental land mass is 2,500 miles away.

One of Hawaii's most beautiful forest birds, the `i`iwi sports a long, curved bill that allows it to feed on nectar inside `ohi`a and other native blossoms.

Because the islands were born from undersea volcanoes and were never part of any continent, their native flora and fauna have been able to evolve in strange and mysterious ways. How any plants or animals reached Hawaii in the first place is a marvel in itself. The chain was far from being a Noah's Ark when it began emerging from the ocean some six million years ago. In fact, the newly made islands began as lifeless flows of molten lava: stark, sterile, and completely antiseptic. After the lava cooled, it was the first pioneering plants—together with eons of wind and rain—that built rich soils out of barren rock and held passing moisture to make Hawaii a fertile land for other colonizing life forms.

In the beginning life could reach the islands only three ways: via the ocean, birds, or wind. Invertebrates probably made the trip aboard floating debris carried by the ocean's currents. (Rafts of logs from the Columbia River drainage in the northwestern U.S. sometimes wash up on Hawaiian shores.) Seeds and plants most likely arrived by bird, either as meals that were later defecated or as hitchhikers on feathered backs. Some insects probably came that way, too. Plant spores and tiny insects rode the jet stream from all corners of the globe, dropping by chance to one of the islands.

With 2,500 miles of salt water as a barrier, the odds for a successful colonization were always remote. Scientists figure a new taxon of vascular plants successfully colonized the islands about once every 100,000 years. But when species did become established, they apparently fared extremely well, primarily because an incredible array of habitats was open to them. Biologists have identified at least 150 different types of natural communities in the archipelago, ranging from coastal dunes to lava field savannas, from arid scrubland to tropical rain forests, from alpine snowfields to subterranean caverns.

What's more, there's little distance between the different types. On Molokai, for example, only four miles separate the arid leeward scrub of Kawela from rain-soaked Pepeopae Bog. While lowland Kawela averages only 15 inches of rain a year, the nearby summit catches nearly 15 feet. (This may be the world's most radical change in rainfall within a short distance.) Then, over on the Big Island of Hawaii, a short hike can be like taking a trip from the Archeozoic to the Paleozoic. In just a couple of miles you can walk from a smoldering lifeless lava field that looks like the inside of Vulcan's forge to a rain-brushed jungle shaded by tropical ferns. The

Frans Lanting

An adult monk seal and her pup bask in the sun on the Northwest Hawaiian Islands National Wildlife Refuge. Monk seals are one of only two mammals native to Hawaii.

islands' combination of habitat diversity, isolation, and a lack of mainland competitors made it possible for a handful of plant and animal colonists to produce thousands of species that ultimately would bear little resemblance to their common ancestors.

In Hawaii the process of speciation is more pronounced because of the interplay between isolation and rich habitats. Isolation has limited the rate and number of successful colonizations. The relatively few kinds of plants and animals that did make it have evolved into new forms to fill the range of habitats. But isolation continues to enhance this formation of new species even within a particular island. The islands are made up of lava of varying density and hardness. As a result, the ongoing effects of wind and rain carve remote valleys into the volcanoes' flanks—valleys a thousand feet deep and a stone's throw wide. Steep cliffs (called pali) further maroon the isolated valleys' resident flora and fauna, thus forming biotic islands within an island that limit interaction with other gene pools and increase the chances for speciation.

How great is speciation? Consider this: some 2,500 native forms evolved out of only 250 immigrant plants; 15 land birds produced 80 or more Hawaiian species, wading birds excluded; 250 colonizing insects radiated into at least 4,000 species (scientists estimate that at least that many more remain to be described); and about 20 land mollusks appear to have yielded the 1,000 or so species now present. From these few island colonizers developed a lopsided, fragile world by continental standards. With only two native mammals—a bat and a seal—it is a world dominated by insects, snails, and birds.

AMAZING EXAMPLES of adaptive radiation abound on the islands, but surely the most striking is that of the Hawaiian honeycreepers, a family of land birds that shares a single finch-like ancestor. The degree of variation achieved by this family is so extraordinary that it makes the diversification of Darwin's Galapagos finches pale in comparison. While that much lauded subfamily contains about 12 species or subspecies, the number of known Hawaiian honeycreepers (some are extinct) totaled no fewer than 37. Besides many "standard" finches, the assemblage included species that resembled blackbirds, honeyeaters, parrots, tanagers, thrushes, vireos, warblers, and even a uniquely adapted woodpecker.

Like Darwin's finches, the Hawaiian honeycreepers became specialists, diversifying to take advantage of different niches, co-evolving along with ever-changing habitats. For example, the ʻiʻiwi—Hawaii's most colorfully plumed nectarivorous forest bird—developed a long decurved bill

Photos by John H. Carothers

Though the birds share a common ancestor, the Maui creeper (top) eats insects and the crested honeycreeper (above) feeds on nectar. Both species are known only from the rain forests of Haleakala where they are protected on the Conservancy's Waikamoi Preserve.

Keith H. Murakami/Tom Stack & Assoc.

A distant cousin of the water-loving Canada goose, the nene chose a dry environment upon settling in Hawaii and eventually lost half the webbing on its feet.

apparently to match the shape of the blossoms of the `ohi`a and giant lobelias it depends upon for food. Its cousin the palila, on the other hand, retained a finch-like bill, allowing it to feed on the seed pods of the mamane tree.

They weren't the only type of birds to evolve into distinctive new species. The nene descended from the same ancestral stock as the Canada goose, but upon reaching Hawaii it settled in drier rocky grasslands and savannas. Having lost its need to swim, the nene eventually shed half the webbing on its feet. Still other immigrating species gave up their ability to fly. There were no predators to worry about, so why expend energy maintaining muscles and bones for flight? Ornithologists believe that no fewer than 17 of 45 Hawaiian birds now extinct were flightless.

Plants, too, evolved into never-before-seen species. There are violets turned arborescent, growing on woody trunks 12 feet long. Lobeliads number in the hundreds; you'd hardly recognize them as relatives of the kind you grow in your garden at home. *Delissea undulata*, for instance, sports white and green flowers and purple-black fruits clustered at the top of a 20-foot-long stem as bare as a fishing pole. Native mints—of which there are at least 50—lost their aromatic oils, which are believed to be a defense against over-browsing. The world-famous silversword found in Haleakala Crater on Maui may have been a simple daisy when it first touched Hawaiian shores.

Insects also radiated when they reached paradise. Scientists at the University of Hawaii have identified 500 species of endemic pomace flies, collected an additional 200 species that still need to be described, and estimate that another 200 await discovery. All this from a single, or at most two, original colonists.

Adaptation has caused some bizarre behavior. There are caterpillars that hide themselves in the notches of leaves and prey on other insects as they alight. They are the only known ambushing, carnivorous caterpillars in the world. There are flightless flies and even underground denizens called no-eyed big-eyed jumping spiders. Imagine.

THIS EDEN of endemism lost its innocence, however, with the arrival of one particular species that adapted the environment to itself instead of the other way around—*Homo sapiens*. The first to reach Hawaiian soil were migrating Polynesians who sailed their slender-hulled outrigger canoes up from the South Pacific some 1,600 years ago. They transported whole landscapes with them, introducing to Hawaii scores of exotic plants like taro, yams, bananas, and breadfruit. They also

Joel Lau

Keith Murakami/Tom Stack & Assoc.

Robert Gustafson

The silversword's blossoms (top) bear a striking resemblance to a common garden species, the daisy—which may be a close relative. Looking like a science fiction version of another plant commonly found in mainland gardens, the giant lobelia (left) can grow to 25 feet. Hesperomannia arbuscula *(above), an endangered endemic species, is found only on Oahu and West Maui.*

brought 16 new species of animals, including domestic pigs, dogs, jungle fowl, and such stowaways as rats, geckos, and skinks.

The introduction of exotics accelerated exponentially beginning in the 18th century when Captain James Cook happened upon the islands while searching in vain for the fabled Northwest Passage. His discovery touched off a biological barrage of influences from every corner of the globe that continues to this day.

The number of exotic plants that have taken root in Hawaii is mind-boggling: about 4,000 different species, say scientists. The listing of introduced trees sounds like a roster for the United Nations of botany. There are Japanese cedar, Chinese fan palm, Java plum, African tulip, Oregon ash, and Mexican ash—to name just a few.

Exotic insects are pouring in at a rate of two dozen species a year. One group alone, ants, now fields 42 different species in Hawaii.

People also brought in more than 150 different types of birds. At least 70 have become established. The first major introduction occurred in 1865 when mynas, ricebirds, and skylarks were imported. Throughout that century notices were placed in newspapers urging ship captains to bring others.

What effect has all this had? The statistics are grim. Nearly 80 percent of the original habitat below 1,500 feet was severely altered by the year 1800, most of it by the early Hawaiians' use of fire. Around 800 endemic plants are considered endangered today, most of these in low- and mid-elevation remnants of native vegetation. Since 1778 nearly 40 percent of the 70 identified endemic bird species have been lost. Of those that remain,

Ed Misaki

Alan Holt

A Conservancy volunteer (above) erects fencing on Kamakou Preserve to protect native ecosystems from pigs, which are one of the most destructive introduced species on the islands. On the West Maui summit (right), an entire ecological region is still untouched by exotic mammals.

30 are classified by the U.S. Fish and Wildlife Service as threatened or endangered, accounting for almost half of the U.S. entries in the Red Data Book of the world's endangered fauna. Only one other region in the world surpasses it for the number of birds to have become extinct—the Mascarene Islands in the Indian Ocean. But if you add subspecies or geographical races to the Hawaiian list, America's paradise state has the dubious distinction of being first in the world. The extinction wave is not over. Today, five forest bird species are down to such low numbers that they may very well join their fossil relatives in oblivion by the end of this century.

Nonetheless, many conservationists in Hawaii believe that the wave of man-induced extinctions can be halted. "We have lost a great deal, and we'll lose more species before we've slowed the rate," says Alan Holt, director of science and stewardship for the Conservancy's Hawaii Field Office. "But nearly half of Hawaii's original native ecosystems is still here, harboring thousands of endemic plant and animal species. Moreover, we now have or are developing the tools to protect them."

In the past 15 years, experience gained from research and management in Hawaii's parks and preserves has produced a much more complete picture of the problems inherent in island ecosystems and has helped to create some promising solutions to them as well. "Keeping non-native disturbances to a minimum appears to be essential to protecting island ecosystems," says Holt. Feral mammals, especially pigs and goats, are at the top of the list of "non-native disturbances" in Holt's mind. "It is only in areas where these animals have broken up the native vegetation by browsing and trampling that foreign plants are able to take over. Once the native flora has been crowded out, introduced insects and birds—which may carry avian disease to the islands' endemic birds—move in." Fire (believed to have been an uncommon event in native Hawaiian systems before the arrival of humans) is another disturbance that opens up areas to invasion by introduced species. "We have the know-how to protect many upland areas from these disruptions," Holt explains, "and we are working on solutions for safeguarding the more fragmented lowlands."

Looking back at what's been done to save Hawaiian ecosystems, the Conservancy and others acknowledge a need to do more and to do it now. "Most of what is now protected on our five preserves and in other refuges is upland forest and alpine shrubland," says Kelvin Taketa, director of the Hawaii Field Office. "Although more vital

watersheds and forest bird habitat require protection, we also must strive to preserve the islands' full array of native ecosystems."

Taketa speaks of places like the beach at Mo`omomi on Molokai (see page 14) where sea turtles, Monk seals, and Laysan albatross are attempting to recolonize amidst the islands' finest coastal vegetation. Or the Pelekunu Valley, which embraces one of the state's last remaining free-flowing freshwater streams. Or the summit bogs and forests of West Maui where an entire ecological region is still untouched by pigs or other hoofed mammals. His list—the work of the state's most active field biologists under the Hawaii Heritage Program—also includes dry forests, coastal ponds, waterbird habitat, perennial streams, and lava caves. The areas targeted for protection occur on each of the main islands. "Together with securing this array of sites and funding their long-term management, we have set out to demonstrate why sound stewardship is crucial to preserving such island ecosystems," says Taketa. "Moreover, what we accomplish here will be of use on islands throughout the Pacific."

Living on islands, the people of Hawaii are coming face to face with the limits of many of their natural resources. By learning to strike a balance between human needs and the continued existence of Hawaii's last native natural communities, the citizens of our fiftieth state can also demonstrate to mankind a workable formula for ensuring the survival of life on our island Earth.

Dwight Holing is a California-based writer specializing in wildlife conservation and environmental issues. He has written for *Audubon, National Wildlife, Defenders,* and *Pacific Discovery.*

Richard A. Cooke III

The Dunes of Mo`omomi

by Samuel M. Gon III

THE RISING SUN reveals tracks left by sea turtles that came ashore the previous night to lay their eggs, and morning glory vines wreathe the nesting excavations in the white coral sands. The cool air and the mild voice of the sea give no portent of the predictable, salt-laden winds that will arise later in the day—winds that shape the dunes of Mo`omomi.

Created by strong and steady northeast trade winds that carry beach sands far inland, these linear dunes sometimes extend a mile long and hundreds of feet wide. When seen from above, they cut across the lowlands of West Molokai—isolating Kalaeoka-`ilio (The Dog's Point) from the rest of the island— and, like pale fingers, disclose the path of the prevailing trades. A section of the coastline here is aptly named Keonelele—"the flying sands."

The winds that design Mo`omomi's dunes sweep with moisture-laden air past the lowlands and then upslope to altitudes where the moisture can no longer be held. There the montane rain forests are dark green with trees festooned in moss. Yet fewer than five miles away at Mo`omomi, the desert-like coast feels none of this moisture.

Coastal dunes like those of Mo`omomi were once common throughout the Hawaiian islands, but almost all have been destroyed by sand mining and urban development. As a result, Hawaiian green sea turtles were extirpated from the eight main islands of the Hawaiian chain and today are found primarily on the farthest northwestern islands and shoals. Only recently protected, they now are attempting to regain their prehistoric breeding grounds at such places as Mo`omomi.

AT FIRST GLANCE the dunes of Mo`omomi appear nearly barren. The far cliffs of Mokio are dim in the salt haze, and arid scrub—wind-

whipped into curious forms—clings tenaciously to the sandy soils. And yet the site is rich in life; indeed, it is a last refuge for Hawaiian coastal vegetation. Within vast, integrated communities of nearly undisturbed native grasses and shrubs grow more rare coastal species than in any other single place in the islands. What remains at Mo`omomi is a vestige of a major Hawaiian coastal ecosystem, a holdover from an ancient era.

Alan Holt

Here, shrubby ocean naupaka (*Scaevola sericea*)— the most common of the islands' native coastal plants—shares the coastal strand with a beach morning glory, pohuehue (*Ipomoea pes-caprae*), and with a mix of less frequently seen endemic Hawaiian plants. Carpets of rolling `aki`aki grasslands provide a stabilized bed in the shifting dunes for a rare native nightshade, *Solanum nelsoni.* In exposed patches of red volcanic soil, an endangered beach legume, the `ohai (*Sesbania tomentosa*) flaunts its brilliant salmon flowers set on low-lying branches that seem espaliered by the wind against a backdrop of rocky terrain. No fewer than five globally endangered plant species make their last stand at Mo`omomi.

Among these is a native *Gnaphalium*, called `ena`ena by the Hawaiians, that punctuates the sandstone plain with radiant white foliage. Its

Richard A. Cooke III

William P. Mull

Mo`omomi is the finest remaining refuge for Hawaiian coastal vegetation in the main Hawaiian islands. Gnaphalium sandwicensium *var.* molokaiense *(upper left)—a candidate for federal listing—and* Heliotropium anomalum *(above) are both native species that grow fine, sun-reflective hairs on their leaves to protect them from the parched environment.* Sesbania tomentosa *var.* molokaiense *(left), a beach legume known only from Mo`omomi and also a candidate species, grows in exposed patches of volcanic soil adjoining the dunes.*

Richard A. Cooke III

Lithified dunes—settled sand that has petrified because of the dry conditions—sometimes expose evidence of ancient occupation by native Hawaiians.

succulent leaves are thickly covered with fine, sun-reflecting hairs—a protective strategy common on the parched flats of Mo`omomi. Another native plant, a heliotrope, forms silvery mats in the lee of consolidated dune crests. Its whorled, diminutive leaves also are clothed with delicate reflective hairs. The heliotrope's Hawaiian name, hinahina, evokes an image of the moon rising fully over an ocean horizon. (In Hawaiian mythology, the moon embodied a goddess, Hina—the mother of the island of Molokai. It seems appropriate that the island chain's best examples of hinahina occur on Molokai.)

MO`OMOMI is far more than a superb showcase for shoreline vegetation. The dry conditions that predominate here on the coast cause settled sand to lithify—to petrify or turn into stone. Where ocean waves cut low escarpments into some of these lithified dunes and soil layers, they sometimes expose evidence of long occupation by native Hawaiians. Layers of crab claws and the shells of `opihi (a limpet still savored today) glint in the dark red volcanic clays, and a thin band of charcoal-stained soil reveals where a coastal house site once stood. The fishing was good long ago at Mo`omomi, even as it is today.

But more than good fishing lured early Hawaiians. Scattered shards of dark volcanic stone contrast starkly with the salt-crusted white sandstone of the petrified dune flats. They are the residuum of ancient adze makers. Dense basalt from the throats of volcanoes were the best materials for making stone adzes, the Hawaiian's major hewing tools. Near Mo`omomi, the extinct cinder cone Pu`u Kaeo was a prime source of the fine-grained basaltic rock. Archaeologists also have found the hammerstones used to shape the tools in addition to the rectangular, roughly adze-sized products—called "blanks"— that were then carried away for final working in villages throughout the island.

Mo`omomi is still a special place for the Hawaiian people, some of whom recall the medicinal uses of the area's coastal herbs. Others continue to enjoy the rich marine resources through fishing, harvesting `opihi and edible seaweeds, or swimming in the clear aquamarine waters.

THE DUNES of Mo`omomi hold other treasures as well, some discovered more recently. In places where the lithified dunes are overlain by red volcanic clays (sedimentary in origin), and where wind or waves have cut through the clay and sand layers, the fossils of extinct Hawaiian birds or shells of land snails often are revealed. Some of the most interesting discoveries in Hawaiian paleontology have been made at Mo`omomi. For instance, a giant flightless native goose once foraged in the dry forests of the upper gulches.

The Mo`omomi fossils show that the Hawaiian avifauna, already famous as an example of diversification in an island environment, must have been far more varied than we previously had thought. Although no native eagles now occur in the islands, the bones of one were unearthed at Mo`omomi. So were the fossils of a long-legged bird-eating owl, a thick-billed crow, a flightless ibis, and a series of small honeycreepers similar to those inhabiting Hawaiian rain forests today. No scientist has ever seen any of these creatures alive. Yet the above now-extinct species along with extant bird species currently relegated to the islands' most isolated peaks once existed side-by-side at sea level—at Mo`omomi.

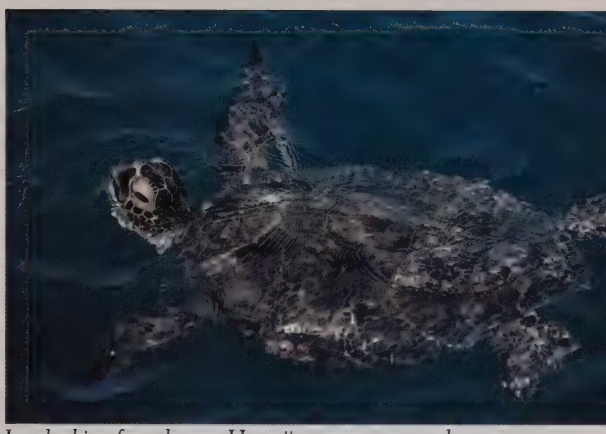
The extinct birds of prey, in particular, filled a niche now occupied by only two relatively rare Hawaiian raptors: the `io, or Hawaiian hawk, and the pueo, or Hawaiian owl. If Hawaii's original avifauna included as many predatory species as the fossil evidence indicates, then the raptors' effect on the small forest birds (their primary prey) must have been great. This fact may well explain why many of today's Hawaiian forest birds are green when immature: camouflaged within their forest foliage, they perch hidden from the eyes of predators now extinct.

On some of Mo`omomi's partially lithified dunes are large "stands" of what appear to be branched lightning bolts of sand. As plants were smothered by drifting dunes, moisture and chemicals leaching from their roots caused the sand nearest the roots to solidify first and hardest. Later, as eroding winds gradually wore away the less consolidated sands surrounding the roots, only the sand casts remained: ghosts of the dune-choked vegetation.

Resembling abstract sculpture, root casts survive as testimony to the restless forces of wind and sand on Mo`omomi.

Richard A. Cooke III

Frans Lanting



Just looking for a home: Hawaiian green sea turtles are trying to recolonize Mo`omomi after having been driven from the inhabited Hawaiian islands long ago.

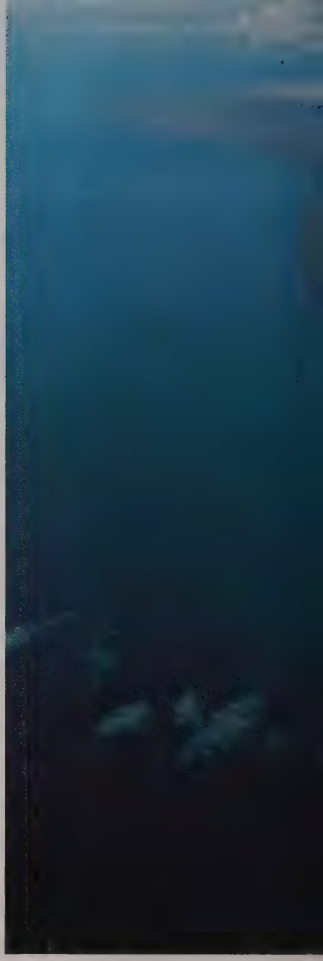
IT IS DIFFICULT to picture the ancient dry forest that once stood where Mo`omomi's dunes now hold sway. But, from what we know of remnant lowland dry forests at other sites in the Hawaiian islands, a diverse blending of trees with no single dominant species might have existed. Here in the dappled sunlight beneath the forest canopy, honks of giant flightless geese once joined the chorus of the ocean waves. Today the dunes and their specialized flora distinguish Mo`omomi, and the sands have preserved the area's singular fossils and artifacts.

As a protection priority of the Hawaii Field Office's "Islands of Life" Campaign, Mo`omomi truly reflects Hawaii's phenomenal range of native habitats and natural communities. These botanical gems set in the arid coast lie only 15 miles from where the clouds hide the delicate rain forests of the Conservancy's Kamakou Preserve.

The coastlines of the Hawaiian islands perhaps have seen more change than any other biological zone in the entire chain. No wonder so many people regard saving Mo`omomi as a rare opportunity to preserve a living portion of the past for the future. The Hawaiian green sea turtles attempting to recolonize here are a hopeful sign that the coastal dunes can endure, even recover, if we acknowledge their significance with action.

The ecologist for the Hawaii Heritage Program, **Dr. Samuel Gon III** is a biologist who has spent more than ten years pursuing field research in Hawaii's backcountry. He has published many scientific papers dealing with ecology, botany, and invertebrate biology.

A Portfolio/Hawaii



Richard A. Cooke III

Left: A waterfall at the headwall of Waikolu tumbles through the lush vegetation on the northern edge of Kamakou Preserve.

Richard A. Cooke III

Peter Menzel

The climate of Molokai (above) changes dramatically over a short distance, from some 150 inches of rain per year in the mountainous forests of Kamakou—where the endemic tree fern Cibotium glaucum *grows (right)—to as little as 15 inches of rain per year in the dry areas to the West.*

Peter Menzel

Waikamoi Preserve, on the north and northwestern slopes of Maui's Haleakala Volcano, is rugged and spectacular. A rich succession of native plant communities, including misty `ohi`a forests (left), unfurls between the rim of the volcano's crater, at 8,640 feet, and the preserve's boundary 4,240 feet below. Of the 272 native plant species described from the preserve, 211—including Sadleria cyatheoides *(above)—are endemic to Hawaii.*

John H. Carothers

Richard A. Cooke III

The centerpiece of Hawaii's "Islands of Life" Campaign, Mo`omomi harbors at least five rare or endangered endemic plant species, and supports many types of indigenous vegetation, such as (right) a beach morning glory (Ipomoea pes-caprae). *The Pelekunu Valley (above), another target of the campaign, embraces one of Hawaii's last remaining free-flowing freshwater streams.*

ECOLOGY FORUM

No. 63
by Dr. Kenneth Y. Kaneshiro
Director, Hawaiian Evolutionary Biology Program
and Dr. Hampton L. Carson
Professor Emeritus, Department of Genetics,
University of Hawaii-Honolulu

SEXUAL SELECTION AND THE POMACE FLY

In Hawaii, unlike the continents where evolutionary processes have reached a state of equilibrium, we are still able to witness the most dynamic stages of evolution. With a native biota composed primarily of endemic life forms—and with the world's most active volcano producing new habitats to be colonized—the Hawaiian archipelago is one of the planet's greatest natural laboratories for the study of evolution. The dynamic process of colonizing species fanning out from island to island is still happening today. Research on evolution in Hawaiian species has already produced results of great scientific and utilitarian value.

For example, more than two decades of multidisciplinary research involving an international team of biologists have been invested in understanding the evolutionary history of a group of flies found only in the Hawaiian islands. Some 500 species of pomace flies in the family Drosophilidae have been named and described from these islands, and approximately 200 additional species await taxonomic treatment at the University of Hawaii. Entomologists estimate that this family of flies may contain as many as 1,000 species, all unique to the Hawaiian islands and all evolved from a single (or at most two) colonizing species. Given the geological newness of the islands and the minuscule land mass involved, this group of flies represents one of the animal kingdom's most remarkable examples of explosive adaptive radiation.

Experts in the fields of systematics, morphology, ecology, behavior, genetics, physiology, biochemistry, and developmental and molecular biology have come to Hawaii to study the unusual ecosystems found here and have pooled their efforts in an attempt to answer some of the same kinds of questions Charles Darwin asked in developing his classical theories of natural selection and evolution. How do we explain the tremendous proliferation of species observed in such groups as the endemic Hawaiian pomace flies? What evolutionary processes and mechanisms have been responsible for enabling such a large number of closely related species to adapt and coexist in the island's diverse environment? What kinds of initial genetic changes are crucial during the evolution of new species? Modern technology has equipped biologists with tools that may provide answers to some of the most puzzling questions being asked about the development of life on Earth.

Extensive studies of the Hawaiian drosophilids have provided answers to some of these questions and, in most cases, have confirmed classical concepts of evolutionary theory. However, some of the evidence has radically altered our thinking on the processes of evolution. Studies of these flies indicate that the forces of natural selection (selection by external environmental factors) have played a less significant role than classical theory suggests. During the early stages of the formation of endemic species, adjustments within the sexual environment are most important.

In stark contrast to continental species of pomace flies, where many closely related pairs or even groups of species are physically indistinguishable (referred to as sibling species), closely related species in the Hawaiian fauna exhibit striking differences in the male fly's external appearance. The males have developed bizarre physical structures that are often used during some phase of the complex courtship pattern. In most cases the males of each species can be readily distinguished from males of other species based on their appearance and on their elaborate courtship dances. Furthermore, scientists discovered that males form "leks" or aggregations to which females are attracted for mating. At these lek sites or mating arenas, males

occupy individual territories and establish a hierarchy where the most dominant (or alpha) male is able to occupy and defend the best territory within a particular lek system. These alpha males then have the best opportunity to encounter and consequently to mate with receptive females that may be attracted to the arenas. The lek mating system, courtship dance, and secondary male sexual structures intensify the sexual selection process and assure mating between the best genetic combinations for the survival of the species.

The results of research on the Hawaiian pomace flies have changed the way many scientists approach the study of population structure and dynamics in general. Darwin's theory of sexual selection, largely ignored for nearly a century, is now believed to form the more important component of the speciation process, not just in drosophilids but in other life forms as well. This rejuvenated concept has both medical and economic significance. For instance, the following example illustrates how basic research on Hawaiian drosophilids is being applied to help agriculturists destroy pests without harming our natural environment.

A few years ago, the United States Department of Agriculture developed a plan to eradicate three species of fruit flies from Hawaii. The Mediterranean fruit fly (or medfly), the Oriental fruit fly, and the melon fly—three of the most formidable agricultural pests in the world—are well-established in the Hawaiian islands and pose a constant threat to the multi-billion dollar commercial fruit market in the United States. When proposed by the USDA, the Tri-Fly Eradication Plan relied primarily on a program known as the Sterile Insect Release Method (SIRM). The SIRM involves the release of millions of laboratory-reared flies sterilized by gamma radiation during the late pupal stage. The basic philosophy of this control technique is that the sterilized males would mate with the females in the wild population. This would result in the laying of unfertilized eggs. The effectiveness of such a control program is totally dependent on the ability of the laboratory-reared sterilized males to out-compete the wild males in mating with the wild females.

The plan originally proposed by the USDA also involved extensive aerial spraying with a protein-based bait laced with the insecticide malathion in order to knock down the wild population prior to implementation of the SIRM. The rationale for using the insecticide was to improve the odds in favor of the sterilized males in mating with the wild females. Such a plan to apply massive amounts of a chemical insecticide threatened the existence of countless endemic Hawaiian species and seemed senseless in view of other alternatives that could be developed.

Moreover, the need to use insecticides to increase the effectiveness of the SIRM implies that the mating ability of the laboratory-reared males is less than optimum compared to that of the wild males. Clearly, information about the behavioral ecology of the fruit flies is crucial to the effectiveness of the SIRM control program. Yet at the time that the USDA was developing its proposal, little or no information on the mating system of the natural population was available. Because of our experience with the mating systems of the Hawaiian pomace flies, we have since discovered that medfly males also form leks in the natural population, and that sexual selection similar to that observed in the Hawaiian drosophilids plays an important role in the medfly's mate choice. Furthermore, we have found that the naturally occurring lek arenas in the medfly habitat are long-term, lasting more than a few years. Unless the laboratory-reared males are able to locate and penetrate the natural lek systems, their ability to encounter the wild females—let alone to succeed in satisfying the mating requirements—will be much reduced.

Our understanding of the complex mating pattern in the endemic drosophilid species in Hawaii has enabled us to develop a method by which we now are able to produce a laboratory strain of flies that contains males with superior mating abilities. We discovered that in Hawaiian flies the mate recognition system between the two sexes is genetically controlled. By selecting for these genetically correlated characters in the two sexes simultaneously—breeding males that boast the best physical structure and the best mating dances as well as choosy females that will accept only exemplary males as mates—we are able to obtain laboratory strains with the desired physical and behavioral characteristics within a few generations. The same selection protocol can be applied to our efforts in improving the behavioral quality of laboratory-reared medfly strains. If we are successful in developing a medfly strain containing males with superior mating ability, males that can then be sterilized and released into the natural populations, it is conceivable that when the SIRM program is implemented, control may be achieved without the need to use excessive amounts of insecticides to knock down the wild population.

Our studies of the Hawaiian pomace flies have provided us with a solid foundation upon which we now may be able to develop more effective control methods for pest species, perhaps even eliminating the need to inject more dangerous pesticides into our environment. But this is not the only success story that could be written about research on the islands' native species. Investigations into the evolutionary biology of other native plants and animals

in Hawaii's natural treasury are uncovering important applications as well.

With the enormous advancements in the field of genetic engineering in recent years, and the ability to transfer genetic material between species, it is even more important today that the genetic resources present in our native ecosystem be preserved and studied in the same way that we have studied the Hawaiian drosophilids. Only then will we be able to understand our own place in this biosphere and take advantage of modern technology to make Earth a better and cleaner place to live.

PHOTOGRAPHY WORKSHOP

On the weekend of May 8 - 10, 1986, a nature and wildlife photography workshop will be held at the Virginia Coast Reserve. Both amateur and professional photographers are invited to learn techniques of nature photography through lectures, slide shows, and field trips to the barrier islands that make up the Reserve. For more information about this workshop and other spring natural history programs, write: John M. Hall, Virginia Coast Reserve, Brownsville, Nassawadox, VA 23413; or call (804) 442-3049.

SINK YOUR TEETH INTO A TRADE LANDS DEAL

Find out how your gift of appreciated real estate can help the Conservancy provide shelter for wildlife . . . and for your income. We can put your surplus property to work for conservation, while bringing you:

- federal and state tax savings
- fast disposition
- elimination of ownership costs
- honorary life membership

For more information, write: Barbara Kerley, Trade Lands, The Nature Conservancy, 1800 N. Kent Street, Arlington, VA 22209; or call (703) 841-5327.

NATURE

Since December 28, 1986, The Nature Conservancy has been participating in the presentation of *Nature*, a natural history series on public television.

A national presentation of WNET-New York in association with The Nature Conservancy, *Nature* is made possible by grants from public TV stations and the American Gas Association. The series is seen weekly on most Public Broadcasting Service stations. Robert E. Jenkins, the Conservancy's Vice President for Science Programs, is the principal science advisor to the series.

The following is the schedule of upcoming programs (check local listings for exact dates and times):

Feb 15	And Then the Rains Came
Feb 22	Fujisan 1 - See No Evil
March 1	Fujisan 2 - Bird of Happiness
March 8	Fujisan 3 - Long Live the Turtle
March 15	Wild Horses
March 22	Soft Feed: The Plant Hunters
March 29	Kalahari: Wilderness Without Water
April 5	One Man's Island
April 12	Holy Land 1: A Wilderness Like Eden
April 19	Holy Land 2: Sweet Water, Bitter Sea
April 26	Garden Life*
May 3	Selva Verde
May 10	Lords of Hokkaido
May 17	Animal Builders*
May 24	Masked Monkeys
May 31	The Feathered Swarm
June 7	Battle of the Leaves
June 14	The Gooneys of Midway
June 21	Emas: High Plains of Brazil
June 28	The Skyhunters
July 5	Aspen - Dancer on the Wind
July 12	Where Eagles Fly

*working title

The Nature Conservancy is proud to be associated with this highly acclaimed natural history series. We hope you'll be watching.

NEW PROJECTS

ARKANSAS

Cache River/Bayou DeView National Wildlife Refuge—Addition—(Prairie and Monroe Counties). Lying within the Mississippi River Delta, northeastern Arkansas draws the largest concentration of wintering mallards in the nation, averaging about one-third of the total Mississippi Flyway population. The region's "magnet" is the Cache River and its more than 100,000 acres of surrounding swamp and bottomland hardwoods: key waterfowl habitat. A 3,296-acre purchase nearly triples the amount of protected acreage. A National Wetlands Conservation Project, the 4,661-acre site is managed by the U.S. Fish and Wildlife Service as part of the wildlife refuge.

CALIFORNIA

Coachella Valley—Addition—(Riverside County). This desert oasis near Palm Springs sustains one of the state's largest groves of increasingly scarce desert fan palms (*Washingtonia filifera*), and its surrounding sand dunes are habitat for the nationally threatened Coachella Valley fringe-toed lizard. Conservancy-acquired land here now totals 11,029 acres, including this ten-acre purchase. Targeted by the National Wetlands Conservation Project and the Katharine Ordway Endangered Species Conservation Program, the 13,000-acre refuge is managed cooperatively by the Conservancy, the Bureau of Land Management, the U.S. Fish and Wildlife Service (which will receive the new addition), and the California Department of Fish and Game.

Pygmy Forest—Addition—(Mendocino County). Endemic to northwestern coastal California, the endangered Mendocino pygmy cypress forest occurs only on highly acidic, nutrient-poor soil called Blacklock. The community hosts several types of flora listed in the California Native Plant Society's inventory of rare and endangered vascular plants including pygmy cypress (*Cupressus pygmaea*) and Bolander's pine (*Pinus contorta* ssp. *bolanderi*). The latter is endemic to pygmy forests and in 50 or 60 years may reach heights of only one to two feet. A project of the Wild California Campaign, the 40-acre preserve—including a 10-acre purchase—is managed by the California Field Office.

CONNECTICUT

Shepaug Dam—Addition—(Town of Southbury). Rocky outcroppings and hemlock gorges along the Housatonic River protect important feeding and day-roosting habitat for wintering bald eagles. The Connecticut Chapter previously negotiated a management agreement with Northeast Utilities on 30 acres here, but this 50-acre gift of Catherine L. McCarthy is the first parcel the Conservancy owns in fee. The site is managed by the field office.

FLORIDA

Suwannee River Project—Addition—(Hamilton County). With the purchase of a strategic 216-acre tract that boasts one-and-a-half miles of frontage on the Upper Suwannee, Conservancy-protected acreage here now stands at 35,596. The addition, which shares a heron rookery (one of only three in the Suwannee River floodplain) with an adjacent parcel, has been transferred to the Suwannee River Water Management District.

Wakulla Springs (Wakulla County). Visitors to Wakulla Springs might recognize it as the setting for Tarzan movies, while archaeologists know the area for the nearly complete mastodon skeleton found there. But to conservationists, the attraction is the site's six natural communities: aquatic cave, spring-run stream, floodplain swamp, floodplain forest, upland hardwood, and upland mixed forest. In addition, the sanctuary harbors Woodville cave crayfish (a globally endangered endemic species) and three species of special concern in the state—gopher tortoise, alligator snapping turtle, and Suwannee cooter. The Conservancy and the Northwest Florida Water Management District jointly acquired 3,000 acres. The parcel will be repurchased by the state's Conservation and Recreation Land Trust Fund and will be managed by the Florida Department of Natural Resources as a state park.

IDAHO

Priest Lake State Park (Bonner County). The Conservancy has purchased 293 acres in northern Idaho below the Selkirk Crest in a cooperative effort with the state's Parks and Recreation Department, which manages the site. Embracing some 280 acres of heavily-forested woodland and all the property fronting the lake's Squaw Bay, the park is surrounded by potential habitat for the federally protected woodland caribou.

MARYLAND

Cypress Swamp Marsh (Worcester County). This fresh intertidal marsh on the Pocomoke River is seasonally adorned with the vivid blue flowers of *Lobelia elongata* and the bright orange blooms of *Asclepias lanceolata,* two species uncommon in the state. The wetland also supports a plant critically endangered in Maryland—*Carex hyalinolepis.* Identified by the heritage program as a possible addition to Hickory Point Wildland (a state-designated wilderness area), the 282-acre parcel was purchased cooperatively with the Maryland Department of Natural Resources, which manages the tract.

Nassawango Creek—Addition—(Worcester County). A 29-acre purchase extends Conservancy holdings along a 15-mile corridor of Nassawango Creek—a tributary of the blackwater Pocomoke River on Maryland's Eastern Shore. Now spanning 2,689 acres, the sanctuary encompasses a bald cypress/sweet gum swamp: home for some 17 warbler species. The site is managed by the Conservancy's Nassawango Creek Stewardship Committee.

MICHIGAN

Skegemog Lake Wildlife Area—Addition—(Kalkaska County). The purchase of a 40-acre parcel brings Conservancy-protected lands here to 2,361 acres. An expanse of swamp and marsh with a fragile bog, the preserve harbors bears, bobcats, river otters, and massasauga rattlesnakes and is a nesting site for bald eagles, loons, and other bird species. The addition will be conveyed to the Michigan Department of Natural Resources.

MINNESOTA

Bluestem Prairie—Addition—(Clay County). At 2,380 acres Bluestem is the largest Conservancy-owned grassland in Minnesota. The preserve shelters nine animals (including greater prairie chickens, marbled godwits, upland sandpipers, Dakota skippers, and prairie voles) and six plants that are of special concern or threatened in the state. This 160-acre purchase is protected through the Northern Prairie Wetlands Program—a component of the National Wetlands Conservation Project. Bluestem Prairie is managed by the Minnesota Chapter as a dedicated state scientific and natural area.

NEW HAMPSHIRE

Wales Preserve—Addition—(Hillsboro County). Nestled in the southeastern foothills of Grand Monadnock Mountain, a 25-acre gift of the Ralph and Betty Wales Trust expands protected acreage here to 48. Managed by the New Hampshire Field Office, the scenic preserve is bordered on the west by the tannin-stained Gridley River, which provides habitat for a great diversity of aquatic plants.

NEW YORK

Maple Swamp/Owl Pond (Suffolk County). One of only five Atlantic white cedar swamps remaining on Long Island, the site harbors three plants threatened in the state—Walter's sedge (*Carex walteriana*), fibrous bladderwort (*Utricularia fibrosa*), and Robin's spikerush (*Eleocharis robbinsii*). *Lithophane lemmeri* and Hessel's hairstreak, two lepidoptera species critically endangered in the state, reportedly occur here as well. The 504-acre parcel, purchased by the Long Island Chapter in a joint effort with Suffolk County, will be placed into the county's aquifer-protecting nature preserve system.

OHIO

Funk Woods—Addition—(Seneca County). A 27-acre gift of Wayne D. Funk completes protection of this 47-acre area, a beech-maple ecosystem that grades to swamp forest. Owing largely to development and agriculture, high-quality occurrences of this community type are rare in north central Ohio. The tract will be transferred to Heidelberg College for inclusion in the research and environmental education preserve.

Sandusky Bay (Sandusky County). A vast wetland system along the southwestern shore of Lake Erie, Sandusky Bay provides a critical resting place for waterfowl on the eastern branch of the Mississippi Flyway. The marshland is also an essential nesting area for Ohio's bald eagle population and is one of the most important staging areas in the country for red-breasted mergansers. A National Wetlands Conservation Project, the 2,938-acre parcel was purchased in a cooperative effort with the state's Division of Wildlife, which will manage the area.

SOUTH CAROLINA

Flat Creek Natural Area and 40-acre Rock—Addition—(Lancaster County). Two flat-rock endemic plants endangered in the state—Puck's orpine (*Sedum pusillum*) and crowned purslane (*Portulaca umbraticola*)—grow on rocky outcroppings lying within this tract. A 156-acre parcel enlarges the natural area to 492 acres. The new tract is being managed by the South Carolina Field Office until it is conveyed to the state's Wildlife and Marine Resources Department.

WISCONSIN

Baraboo Hills Project/Baxter's Hollow: R.D. and Linda Peters Nature Preserve—Addition—(Sauk County). A priority of the Conservancy's National

Wendy Paulson

Nachusa Grasslands

Steep slopes descending into a shallow bowl and poor soils made the prairie here difficult to farm and so, unlike most grasslands in the Midwest, it escaped heavy agricultural development. Nevertheless, when the Conservancy first noticed the property in 1973, much of it was being heavily grazed and was almost unrecognizable as prairie.

By the late 70s, the Illinois Natural Areas Inventory was underway and it identified two small tracts of the Nachusa Grasslands as high quality natural areas. A local farmer became personally interested in the area and convinced landowners to allow him to conduct prescribed burns. More recently, a botanist discovered a rare species, prairie bush clover (*Lespedeza leptostachya*), on one of the heavily grazed parcels. Closer inspection by Conservancy staff revealed that the plant (which has just been federally listed as threatened) occurs all over this prairie in one of the largest known populations in North America. The grassland also harbors three plants under review for federal protection—*Aster furcatus, Asclepias lanuginosa,* and *Castilleja sessiflora*—as well as many unusual insects, including the regal fritillary, a butterfly that inhabits only true prairie.

Nachusa is one of the largest unprotected contiguous grasslands left in Illinois. The site is extraordinarily scenic and diverse, encompassing native prairie, wetlands, and oak savanna (a globally rare community). Managed by the Illinois Field Office, a 138-acre purchased plot is the cornerstone of a preserve that, when completed, will embrace some 900 acres.

Critical Areas Conservation Program, Otter Creek in the Baraboo Hills is a cold-water trout stream used extensively for aquatic invertebrate research. The purchase of 40 acres enhances protection for Otter Creek's watershed—the only undeveloped one in southern Wisconsin—and for a set of essential springs. Now embracing more than 2,757 acres, the sanctuary is managed by the Conservancy's Wisconsin Chapter.

Chiwaukee Prairie-Carol Beach (Kenosha County). In a joint effort with the Wisconsin Department of Natural Resources, the Conservancy purchased five acres in 14 lots—part of a narrow, relatively undeveloped corridor of land along Lake Michigan that harbors scattered wet prairies. The parcels will be donated to the department for management as a natural area.

Decorah Mound—Addition—(Trempealeau County). A ten-acre gift of Harlen and Verneille Hunter boasts a high-quality remnant of dry prairie, a community threatened in the state. Now stretching over 40 acres, the preserve encompasses a classic Mississippi River bluff with a high knob rising 300 feet above the floodplain. Second growth oak-hickory woodland with scattered elm, hackberry, basswood, and white birch covers the bluff slopes. Management will be the responsibility of the Wisconsin Chapter.

Ice Age Trail (Chippewa County). Designated by Congress as a national scenic trail, the Ice Age Trail follows the terminal moraine of the last glacial push and will be 1,000 miles long when completed. Purchased in a cooperative effort with the Ice Age Park and Trail Foundation, the 160-acre parcel bridges a gap in the hiking path between county forest land and a series of spectacular glacial lakes in the Ice Age National Scientific Reserve. The foundation manages the tract.

International Report

Man and Biosphere: An Idea That Works

Can biological conservation and the process of meeting basic human needs be designed to complement each other? In the developing nations of the neotropics, there is no choice. Where hunger, homelessness, and resource scarcity are facts of life for many people, the short-term use of biological resources often seems more urgent than their long-term protection. But heedless use of natural resources usually destroys the resource base, making human life more difficult in the long run—as well as destroying biological diversity.

The Man and Biosphere program (MAB), initiated by UNESCO, is a creative approach to serving both human and conservation needs at designated locations. MAB reserves are generally extremely large areas with a central core dedicated to strict preservation. In the peripheral areas of the reserve, sustainable resource use is developed so that human needs are met in ways that are compatible with resource conservation.

Mexico's 1.2 million-acre Sian Ka'an Reserve on the Caribbean coast of the Yucatan peninsula is an exemplary MAB reserve. The core area includes 70 miles of the world's second longest barrier reef and portions of the adjacent highly productive bays and marshes. Sustainable resource use in the rest of the reserve includes lobster fishing, farming, and a small coconut industry.

"Amigos de Sian Ka'an," a private local organization, played a central role in establishing the reserve and continues to exert a strong force in creating and implementing management policies. "Amigos" is working in a number of ways to improve resource use and living standards for the local population. Their projects include replacing lobster spearfishing (which kills every lobster caught) with net fishing, which allows egg-bearing females and undersized males to be returned; the introduction of sustainable agriculture to take the place of the disastrous slash-and-burn approach; and a research project to rejuvenate the coconut industry, which was wiped out by a viral disease.

The Nature Conservancy Latin American Program is working closely with "Amigos," helping the young organization establish itself for the long haul. We are also working with scientists and conservationists in the mountains east of Guadalajara to help establish a 250,000-acre MAB reserve at the site of *Zea diploperennis*, the perennial corn that is being studied by plant geneticists worldwide.

In eastern Bolivia, the Conservancy established the administrative and scientific headquarters for the 330,000-acre Beni Reserve and coordinates an international team preparing its management plan. Last year we hosted a meeting of UNESCO's MAB committee in La Paz, at which the Beni was designated as a MAB reserve.

Each successful Man and Biosphere reserve proves that man and nature can in fact coexist. In a continuation of the Conservancy's results-oriented philosophy, the Latin American Program will continue working to help convert the powerful MAB concept into effective working reserves.

Field Trips & Tours

A Week in Hawaii

Come join us as we explore the rain forest, dune, and mountain terrain of Hawaii. See the Waikamoi Preserve on the island of Maui where the native forest is home to many of Hawaii's endangered birds. Visit Molokai's Kamakou Preserve and walk through an ancient bog where the forest plants are represented as dwarfs of their species. Take a helicopter ride over some of the most remote valleys in Hawaii and see the highest sea cliffs in the world. Explore Mo`omomi Dunes, home to a unique variety of endangered coastal plants and site of important fossil and archeological discoveries. Relax and enjoy late afternoon and evening hours in first-class resort accommodations.

Each seven-day trip begins on Sunday on the island of Oahu and includes three days on Maui and three days on Molokai before returning to Oahu the following Saturday.

Dates for the Hawaii field trips are:

May 10-16
May 24-30
June 21-27
September 6-12
September 20-26
October 11-17
October 25-31

Space is limited to eight participants per trip, so reserve your space soon. For details, contact the Hawaii Field Office (see back cover).

Explore Montana's Pine Butte

In May the spectacular East Front of the Northern Rockies comes alive with more than 135 species of migrating and nesting birds, plains grizzlies descending from their dens, and brilliant flowering alpine plants. Two of Montana's best naturalists will lead six days of birdwatching in the lush foothills and wetlands of the Pine Butte Swamp Preserve. Wildflower walks, geology treks, and dinosaur fossil hunts will also be offered. Two sessions are available: May 17-23 and May 24-30. The cost is $800 per person (partially tax-deductible), including food and lodging at the preserve's Circle 8 Ranch. **Also, private cabins are available at Circle 8 Ranch, May - October.** Enjoy hiking, horseback riding, wildlife, fishing, swimming, etc. For details on the birding trip and/or the cabins, contact: Cindi McAllister, Pine Butte Swamp, HC 58 Box 34B, Choteau, MT 59422; tel. (406) 466-2377.

Birds Across Oregon

Join the Oregon Chapter for a week-long trek to see nearly 200 species of birds. We will start at the Pacific Coast's precipitous headlands and sea stacks, home of thousands of murres, cormorants, and puffins. Heading eastward, we will cross the Cascade Mountains, where tall coniferous forests host western woodland species such as the white-headed woodpecker, pygmy nuthatch, and hermit warbler. East of the Cascades, we will enter high desert sage and juniper steppe and visit the largest marsh in the contiguous western states: Malheur National Wildlife Refuge. The tour will also include three Nature Conservancy preserves.

There will be four sessions between May 10 and June 20 and four more between August 16 and September 19. Each group is limited to 12 people. Cost is $750 (of which $250 is tax-deductible), including accommodations in hotels, condominiums, and spacious trailers. Travel will be by small Mercedes bus. For details, write: Oregon Birdwatch, c/o Oregon Field Office (see back cover).

CORRECTION

The photo on page 13 of the December/January *News* was incorrectly credited. The photographer was John F. O'Connor, M.D., Photo/Nats.

PRINTS AVAILABLE

After this photograph by Geoff Pampush appeared in our August/September 1986 issue, many members wrote to let us know that they found it especially enchanting—and to find out if copies were available. Therefore, we're offering limited numbers of archive-quality, mounted, 11" x 14" prints through the Oregon Field Office. The price is $30.00 each, postpaid. Write to: Burrowing Owl, The Nature Conservancy, 1234 N.W. 25th, Portland, OR 97210.

NEW LIFE MEMBERS

An individual becomes a Life Member of The Nature Conservancy upon contribution of $1,000 for membership dues or for the Land Preservation Fund, Guarantee & Income Fund, or a state land preservation fund. Husbands and wives may hold a joint life membership for a single qualifying contribution.

Mr. and Mrs. Robert B. Asher
Ms. Edith S. Bingham
Ms. Holly Bowles Blanton
Mr. and Mrs. David H. Bowman, Jr.
Mrs. C.K. Brandrup
Mr. and Mrs. Donald Brennan
Mr. and Mrs. Kevin M. Caldwell
Mrs. Joseph F. Carroll
Mr. and Mrs. Charles Christoph
Dr. Diane R. Conradson
Mr. Stanton A. Cook
Dr. and Mrs. Robert Crafts, Jr.
Mr. and Mrs. Owen Daly II
Dr. and Mrs. Richard B. Darlington
Ms. Deanna K. Dawson
Mr. William Dickerman
Mr. and Mrs. Jack M. Docter
Mr. John T. Dorrance, Jr.
Mr. and Mrs. Richard Drayton
Mr. Kenneth J. Evans
Mrs. Fred C. Ferris
Ms. Polly French
Mr. Richard Goldstein
Mrs. Jack E. Gray
Dr. Roger H. Gray and Ms. Roseann E. Netzer
Mr. and Mrs. John C. Haas
Ms. Anne Hagstrom
Mr. Dale Hagstrom
Ms. Louise H. Hall
Mr. and Mrs. Zenon C.R. Hansen
Mr. Julian D. Hayden
Mr. J.H. Heidel
Mr. and Mrs. Kenneth D. Holland
Mr. Curtis L. Hougen
Mr. and Mrs. Kirk Jeffrey
Mr. and Mrs. H. Reid Jones
Mr. and Mrs. Kent M. Keith
Ms. Olivia R. Koller
Ms. Dorothy S. Leckenby
Mr. and Mrs. Robert B. Leighton
Mr. and Mrs. Forrest W. Lowell
Mr. Roger D. Maddux
Mr. and Mrs. Fred W. Manger, Jr.
Mr. John H. Maris
Dr. and Mrs. David S. Masland
Mr. and Mrs. Richard D. May
Mr. Maxwell L. McCormack, Jr.
Mr. and Mrs. Larry McKinney
Ms. Margo Murman
Mssrs. Al and Vic Muth
Mr. Ron Nestor
Mrs. Francis T. Nichols
Mrs. Glen E. Nielsen
Ms. Alix Ellis Paine
Miss Gail A. Perry
Ms. Mary Pickens
Mr. and Mrs. James L. Potter, Jr.
Mr. Lawrance W. Rathbun
Mr. Richard R. Raup
Mr. and Mrs. Henry T. Reath
Mrs. Don H. Richardson
Mr. James F. Ristow
Mr. and Mrs. John W. Schieffelin
Mr. Robert J. Schloss
Mr. John Shapiro
Ms. K.Z. Sheldon
Mr. and Mrs. Dennis G. Shepherd
Miss Virginia Ruth Slack
Mr. F. Sterling Smith
Mr. and Mrs. Langhorne B. Smith
Mr. and Mrs. Terry J. Smith
Mrs. Agnes C. Stackhouse
Dr. and Mrs. William T. Sueoka
Mr. Charles M. Sukenik
Mrs. JoAnn C. Swingle
Mr. Laurence L. Thayer
Mr. and Mrs. Frederick D. Trauger
Ms. Patricia A. Trumbull
Ms. Karen K. Uhlenbeck
Mr. August Van Dessel, Jr.
Ms. Mary E. Vincent
Mr. and Mrs. Douglas M. Wade
Mr. Randall L. Ward
Mr. and Mrs. Norman C. Weeks
Dr. and Mrs. Robert F. Whitcomb
Mr. Douglas T. Whitneybell
Mr. and Mrs. Richard L. Wildermuth
Mr. Ward W. Woods, Jr.
Mr. and Mrs. Clark H. Woolley
Mr. and Mrs. Joe Zauchner

NEW CORPORATE ASSOCIATES

A corporation becomes a Corporate Associate of The Nature Conservancy upon contributing between $1,000 and $10,000 annually to the operations of the organization.

Cubic Corporation
California

Nevada Bell
Nevada

Occidental Realty Company
Indiana

Salt River Project
Arizona

Teledyne, Inc.
California

4698 116

Eastern Regional Office
294 Washington Street, Room 740
Boston, MA 02108
(617) 542-1908
Dennis Wolkoff, Vice President

Midwest Regional Office
1313 Fifth Street, S.E.
Minneapolis, MN 55414
(612) 379-2207
John W. Humke, Vice President

Southeast Regional Office
P.O. Box 270
Chapel Hill, NC 27514
(919) 967-5493
Thomas Massengale, Vice President

Western Regional Office
785 Market Street
San Francisco, CA 94103
(415) 777-0541
Laurel Mayer, Director

Latin American Program
1785 Massachusetts Ave., N.W.
Washington, DC 20036
(202) 483-0231
Geoffrey S. Barnard, Acting Director

Arizona Field Office
30 N. Tucson Blvd.
Tucson, AZ 85716
(602) 327-4478
Dan Campbell, Director

Arkansas Field Office
300 Spring Building, Suite 717
Little Rock, AR 72201
(501)372-2750
Nancy DeLamar, Director

California Field Office
785 Market Street
San Francisco, CA 94103
(415) 777-0487
Steve McCormick, Director

Colorado Field Office
1244 Pine Street
Boulder, CO 80302
(303) 444-2950
Sydney Macy, Director

Connecticut Chapter
55 High Street
Middletown, CT 06457
(203) 344-0716
Les Corey, Director

Florida Field Office
1331 Palmetto Ave., Suite 205
Winter Park, FL 32789
(305) 628-5887
John Cook, Director

Georgia Field Office
3179 Maple Drive, N.E., Suite 8
Atlanta, GA 30305
(404) 266-8285
Rex Boner, Director

Great Basin Field Office
P.O. Box 11486
Salt Lake City, UT 84147
(801) 521-1034
David Livermore, Director

Great Plains Field Office
1313 Fifth Street, S.E.
Minneapolis, MN 55414
(612) 379-2207
Ross Sublett, Director

Hawaii Field Office
1116 Smith Street, Suite 201
Honolulu, HI 96817
(808) 537-4508
Kelvin Taketa, Director

Idaho Field Office
P.O. Box 64
Sun Valley, ID 83353
(208) 726-3007
Guy Bonnivier, Director

Illinois Field Office
79 West Monroe St., Suite 708
Chicago, IL 60603
(312) 346-8166
Ralph Burnett, Acting Director

Indiana Field Office
4200 N. Michigan Road
Indianapolis, IN 46208
(317) 923-7547
W. William Weeks, Director

Iowa Field Office
424 10th Street, Suite 311
Des Moines, IA 50309
(515) 244-5044
William W. Crews, Director

Kentucky Chapter
P.O. Box 1605
Frankfort, KY 40602
(502) 564-2886
Hugh Archer, Director

Maine Chapter
122 Main Street
Topsham, ME 04086
(207) 729-5181
J. Mason Morfit, Director

Maryland/Delaware Field Office
Chevy Chase Center Office Bldg.
35 Wisconsin Circle, Suite 304
Chevy Chase, MD 20815
(301)656-8673
Steven Hamblin, Director

Massachusetts/Rhode Island Field Office
294 Washington Street, Room 740
Boston, MA 02108
(617) 423-2545
Laura Johnson, Director

Michigan Field Office
Suite E, 531 N. Clippert Street
Lansing, MI 48912
(517) 332-1741
Tom Woiwode, Director

Minnesota Field Office
1313 Fifth Street, S.E.
Minneapolis, MN 55414
(612) 379-2134
Margaret Kohring, Director

Missouri Field Office
2800 S. Brentwood Blvd.
St. Louis, MO 63144
(314) 968-1105
Rod Miller, Director

Montana/Wyoming Field Office
Last Chance Gulch and 6th
P.O. Box 258
Helena, MT 59624
(406) 443-0303
Robert J. Kiesling, Director

New Hampshire Field Office
7 South State Street, Suite 1
Concord, NH 03301
(603) 224-5853
Phillip M. Hoose, Director

New Jersey Field Office
17 Fairmount Road
Pottersville, NJ 07979-9999
(201) 237-3007
Bruce Runnels, Director

New Mexico Field Office
610 Gold Avenue, S.W.
P.O. Box 1846
Albuquerque, NM 87103
(505) 242-2015
John Egbert, Director

New York Field Office
1736 Western Avenue
Albany, NY 12203
(518) 869-6959
Charles Bassett, Director

New York Chapters:

Adirondack Conservancy
P.O. Box 188
Elizabethtown, NY 12932
(518) 873-2610
Timothy Barnett, Director

Central New York Chapter
P.O. Box 175
Ithaca, NY 14850
John A. Gustafson, Chairman

Eastern New York Chapter
1736 Western Avenue
Albany, NY 12203
(518) 869-0453
Anne Williams, Director

Long Island Chapter
P.O. Box 72
Cold Spring Harbor, NY 11724
(516) 367-3225
Andrew Walker, Director

Lower Hudson Chapter
RFD 2, Chestnut Ridge Road
Mt. Kisco, NY 10549
(914) 666-5365
Rosalind Mason Harris, Director

South Fork/Shelter Island Chapter
P.O. Box JJJJ
East Hampton, NY 11937
(516) 324-1330
Russell S. Hoeflich, Director

North Carolina Field Office
P.O. Box 805
Chapel Hill, NC 27514
(919) 967-7007
Katherine Skinner, Director

Ohio Field Office
1504 West 1st Avenue
Columbus, OH 43212
(614) 486-6789
Jeff Knoop, Acting Director

Oklahoma Field Office
320 South Boston, Suite 846
Tulsa, OK 74103
(918) 585-1117
Herb Beattie, Director

Oregon Field Office
1234 N.W. 25th
Portland, OR 97210
(503) 228-9561

Pennsylvania Field Office
1218 Chestnut St., Suite 807
Philadelphia, PA 19107
(215) 925-1065
R.T. Cook, Director

South Carolina Field Office
P.O. Box 5475
Columbia, SC 29250
(803) 254-9049
LaBruce Alexander, Director

Tennessee Field Office
P.O. Box 3017
Nashville, TN 37219
(615) 242-1787
David Jackson, Director

Texas Field Office
321 Alamo Plaza, Suite 240
San Antonio, TX 78205
(512) 224-8774
Andrew Sansom, Director

Vermont Field Office
138 Main Street
Montpelier, VT 05602
(802) 229-4425
Robert J. Klein, Director

Virginia Field Office
619 East High Street, Suite 2
Charlottesville, VA 22901
(804) 295-6106
George Fenwick, Director

Washington/Alaska Field Office
1601 Second Ave., Suite 910
Seattle, WA 98101
(206) 728-9696
Elliot Marks, Director

West Virginia Field Office
922 Quarrier Street, Suite 414
Charleston, WV 25337
(304) 345-4350
Ed Maguire, Director

Wisconsin Field Office
1045 E. Dayton Street, Room 20
Madison, WI 53703
(608) 251-8140
Brent Haglund, Director

The Nature Conservancy

National Office
1800 North Kent Stree
Arlington, Virginia 222
(703) 841-5300

Address Correction Requ

0102324R-1K-024-12/87
MISS HAZEL A JOHNSON
12705 S E RIVER RD #202-E
PORTLAND, OR 97222

NON-PROFIT ORG.
U.S. POSTAGE
PAID
PERMIT NO. 5226
RIVERDALE, MD.